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THESIS

METHODS FOR DETERMINING MEASURES OF EFFECTIVENESS FOR THE MARINE CORPS FINANCE CENTER

by

Douglas C. Lynn

June 1987

Thesis Advisor David R. Whipple, Jr.

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Methods for Determining Measures of Effectiveness for the Marine Corps Finance Center

by

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Captain, United States Marine Corps
B.A., University of Washington, 1976

Submitted in partial fulfillment of the
requirements for the degree of

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from the

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ABSTRACT

This analysis systematically reviews the established organizational goals of the Marine Corps Finance Center in order to determine the objectives or decision criteria for the unit. Specific production output data sets, which can be used to measure how well the objectives are accomplished, are then analyzed. Graphical, parametric, and nonparametric procedures are used to determine distributions, trends, correlation, and significance of the data. A comparison of the weighted-linear and weighted-product methods for aggregating multiple measures of effectiveness is then presented and the results are examined with respect to the specific organizational goal of developing an overall measure of effectiveness.

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I. BACKGROUND AND PROBLEM INTRODUCTION

A. BACKGROUND

The Marine Corps Finance Center (MCFC) is under the operational control of the Fiscal Director of the Marine Corps. The Finance Center's mission is defined as:

1. Command, coordinate, and supervise the disbursements of funds in payment of all active duty, Reserve, and retired members, Fleet Marine Corps Reserve, and survivor annuitants; to pay military allotments; to make payment of public bills and civilian payrolls for areas specifically assigned; and to serve as the systems sponsor for the pay portion of the automated Marine Corps pay and manpower management systems, military allotment system and applicable accounting systems.
2. Provide military personnel administration, civilian personnel administration, administrative and office services; legal assistance; transportation services; communications support; medical and dental services; operation budget and financial accounting functions; family housing; logistics services, including property, accounting, purchasing, warehousing and motor transport; safety support; special services; and such other related support and administrative functions for the Marine Corps Finance Center, Marine Corps Central Design and Programming Activity, and as mutually agreed upon for the Marine Corps Reserve Support Center; and to perform such other duties as may be directed by the Commandant of the Marine Corps. [Ref. 1]

The MCFC is located in Kansas City, Missouri and shares working space in a large building with the General Services Administration, the Internal Revenue Service, and the Marine Corps Central Design and Programming Activity (MCCDPA). The MCFC employs approximately 160 military and 820 civilian personnel. The Finance Center has evolved at the current location over the last eighteen years as a result of relocation of the manpower management and disbursing functions from Headquarters Marine Corps (HQMC) in Washington, D.C.

The automated data processing (ADP) systems which maintain the manpower and disbursing data base are programmed and operated by the MCCDPA staff of approximately 140 military and 230 civilian personnel. These systems maintain data on active, reserve, and retired personnel; data is also maintained for annuitants, allotments, and withholdings. The systems also provide general and accounting data

with which to manage the manpower of the Marine Corps. Entitlements and administrative data are primarily entered through the On-Line Diary (OLD) system for active and reserve personnel. The retired and annuitant systems rely on manual record keeping and automated accounting and disbursement of funds through the Retired Pay Personnel System (REMMPS).

The Deputy Chief of Staff for Manpower at HQMC has cognizance over two units residing at the MCFC. The first unit includes the deputy project manager and staff for the Realtime Finance and Manpower Management Information System (REAL FAMMIS). The project staff is developing a single, integrated manpower and pay system to replace the current systems. A manpower management information systems liaison unit (MPI-LNU) is the second unit located at MCFC and coordinates changes to the data bases for the active, reserve, and retired personnel of the Marine Corps.

The MCFC is functionally divided with a Deputy for Support Services and a Deputy for Financial Management. The Financial Management personnel perform the duties and provide the services listed in the first paragraph of the mission statement (as shown on page 5) while the Support Services personnel accomplish those tasks required to provide the services listed in the second paragraph of the mission statement. Each Deputy has cognizance and control over the section personnel below them. The Support Services sections are titled as offices and the Financial Management sections are titled as divisions.

B. PROBLEM INTRODUCTION

1. Previous Studies

Numerous studies and reports have been generated by Department of Defense personnel and civilian sources regarding the operation and efficiency of the MCFC. Mr. Jim Schachter, an investigative reporter for the *Kansas City Star* published three articles concerning the Finance Center on 21 July 85. Mr. Schacter cited, "The General Accounting Office, the Naval Audit Service, and internal Navy and Marine Corps auditors - in nearly 90 reports from 1978 to 1984 . . .", as reference for numerous allegations against the Finance Center. These articles presented an image of unsatisfactory management of the MCFC which caused a great deal of concern at HQMC and elsewhere throughout the Department of the Navy.

Quotes from Mr. Schacter's article state:

"A review of records and dozens of interviews by the *Kansas City Star* have found that the Marine Corps' systems are error-riddled, poorly managed and vulnerable to fraud because of a breakdown of internal controls."

"The finance center, established in Kansas City in 1967, is a troubled bureaucracy, employees and investigators say. Workers are deployed inefficiently, supervisors are unprofessional, relations between military personnel and civilians are strained and sexual harassment is alleged."

"Major breakdowns identified by auditors include:

• Internal audits estimated nearly $92.5 million in overpayments were made to active-duty Marines in 1983. Estimated underpayments totaled about $7 million. The estimates of total mispayments had grown by more than 70 percent in three years. Pay errors found by auditors in their samplings are corrected, according to Col. Robinson (HQMC, CODE FD). But cost efficiency prohibits reviewing every account and the Marines, he said, have no way of knowing how much of the tens of millions of dollars in estimated overpayments the government loses each year.

• Because some overpayments are not rectified, Marines increasingly leave active service with debts to the government, according to finance center statistics. As of April 30, the finance center was trying to collect more than $9 million from former Marines - 77 percent more than the outstanding debt in 1978.

• As of 1983, the error rate in records on which active-duty Marines' pay was based exceeded 44 percent, according to Marine auditors - 13,284 pay-related errors amid the 30,010 records examined.

• The Naval Audit Service said in a 1984 report that Marine systems provided no assurance that leave was properly accounted for, that re-enlistment bonuses were paid accurately or even that Marines were receiving accurate W-2 forms stating their annual earnings for tax purposes.

• Heavy workloads and computer problems rendered the section of the finance center responsible for paying Marine reserves unable "to function as an effective pay branch", a Marine study team concluded in 1983. Asked in a recent interview to update the section's status, Col. Mertes (CO, MCFC) said, "we're not out of the woods."

• According to a 1984 report by the General Accounting Office, the Marine Corps' system for paying retirees is vulnerable to fraud and abuse. An internal report issued in November (1983) by the inspector general of the Marine Corps and obtained by the *Kansas City Star* rated the finance center "below average" - one ranking above the worst possible - in general administration and personnel administration. The center scored well on other aspects of the highly technical inspection. A year earlier, the Naval Audit Service, which investigates the Marine Corps as well as the Navy, criticized the center in an exhaustive report on civilian personnel activities. The center "didn't always comply with laws and regulations governing civilian payroll and timekeeping functions, and internal controls weren't adequate to prevent fraud, waste and abuse." Navy auditors said.

A Naval Audit Services Management Survey was performed by a Commander Allen in September 1985. This review was done at the request of the Fiscal Director of the Marine Corps as a result of the *Kansas City Star* articles. The primary focus of the report was to:

- Review the organization and management of the Marine Corps Finance Center (MCFC) focusing on:
  - Organizational structure
  - Position management
  - Hiring/promotion practices
  - Span of control
  - Civilian/military coordination
  - Support/relations with functionally related activities
  - Training requirements
- Review other similar activities to determine if their organizational structures/procedures may apply to MCFC.
- Provide recommendations for improving the effectiveness of the MCFC."

Conclusions drawn from Cdr. Allen's analysis include: [Ref. 2]

> "The MCFC has initiated numerous actions as a direct or indirect result of the leadership of the current Commanding Officer. Actions such as the comprehensive review of the Centralized Pay Division, the restructuring of the quality Assurance Division, and the revision of policy on the criteria for hiring supervisors and managers will have significant effects on the organization in the future. Additional changes in the structure and planning functions of the center are necessary to realize maximum benefits from the organization. A corporate planning organization is needed to coordinate all planning elements that are decentralized in the current structure. Formal goals and objectives are not established for the Center and should be formulated between the Fiscal Director and MCFC. Information resources are not centrally managed and controlled resulting in unnecessary costs and inefficiencies.
>
> The following summary of recommendations is provided:
>
> Recommendation 1: Establish formal organizational goals between the Fiscal Director and the Commanding Officer, Marine Corps Finance Center.
>
> Recommendation 2: Combine the planning elements of MCFC into one organization.
>
> Recommendation 3: Establish measures of effectiveness that will indicate how well MCFC is performing its mission."

2. **Author's Observations**

The MCFC staff has subsequently established formal goals approved by the Fiscal Director at HQMC. Efforts are ongoing to create and staff the Informational Resources and Planning section within the organization and to enhance long range planning effectiveness with the increased use of automated systems and microprocessors. The Finance Center Management Analysis Office has initiated a project to define objectives relevant to the established goals. In addition to this, a six-week analysis effort was undertaken as the author's Operations Research experience tour. The primary focus of the author's effort was to analyze the organization in an attempt to develop valid and meaningful measures of effectiveness (MOEs). The six weeks spent at the Finance Center enabled a better understanding of the working environment and the mission requirements of each division within the Finance Center. It also clarified the support requirements which the Marine Corps Reserve Support Center and the Marine Corps Central Data Processing Activity place on the Finance Center. As a result of the experience tour, observations regarding and problems associated with the development of measures of effectiveness are offered throughout the remainder of this paper.

3. **Approach and Methodology**

The general approach used in this analysis was to utilize the established goals in order to define objectives or decision criteria. Specific production output data was identified which reflected the staff's accomplishment of their goals and objectives. This data was then analyzed for distributional information, trend, correlation, and significance. No specific problems were identified which would prevent using these production output data values in the computation of an overall measure of effectiveness for the Finance Center.

The data analysis consisted of a series of graphical and parametric procedures to gather additional information from the data that was already being collected by the Finance Center staff. The graphical procedures employed were simple time-series plots of the original data. The parametric procedures involved computation of the estimated mean and standard deviation of a series of data points. Estimates of the correlation (association) were computed for the data sets. This method of analysis was chosen to enable the Finance Center staff to be able to continue utilizing these techniques without the implementation of vast, expensive, computerized graphical packages, and with relatively little training of the analysts.

The analysis continues by comparing two methods for aggregating multiple MOEs. Advantages and disadvantages of each method are discussed and the results are examined.

II. PROBLEM CLARIFICATION AND DISCUSSION

A significant problem associated with developing measures of effectiveness for the MCFC is the lack of comprehensive data with regard to key topics. A wealth of data for production output and personnel assets exists in the form of the Management Information and Statistical Highlights report (MIR). This report contains information on division and office personnel strength, categories of disbursements, production output measurements, year-to-date comparisons, and data necessary to justify Program Objective Memorandum (POM) initiatives and budget submission. There are over 40 pages of statistics for the individual divisions and offices of the Finance Center. With very few exceptions, the data is all in aggregate form such as:

- 2500 travel vouchers processed
- 15 Program changes submitted
- 4800 payroll entries input online

In addition to the MIR, the Finance Center staff records personnel information in two additional reports. These reports are the Manpower Activity Report (MAR) (this is the organization's table of organization report for both civilian and military personnel to indicate staffing to billet number - it is updated monthly) and the Navy Civilian Personnel Data System (maintained by the MCFC Civilian Personnel Office). Numerous other production output statistics are recorded in individual division, office, and section reports and record files. Problems with this large, diversified amount of data include:

- Nowhere do any of the data address cost of production in terms of personnel or dollars. The command is strictly measuring total output produced by each section, office and division.
- Each report is organized and produced in a different format. The Civilian Personnel Office utilizes a Burrough's computer system for the civilian data base, the Management Assistance Office uses a Zenith PC running a word processing system for the MAR, and the Management Assistance Office uses another Zenith PC running the Lotus 123 program to produce the MIR.
- The inconsistency in the formats prevents immediate translations and comparisons of data. Certain key elements of data are missing or identified in such a manner that they are not immediately usable. Examples are:
    1) Accounting information, for personnel salaries, is not detailed down to the office or division level.

2) Position management is difficult because of inconsistent and inaccurate data in the Navy Civilian Personnel Data Base.

3) Specific records are not kept by the Systems Management Division regarding recommended automated system changes.

4) Methods for computing similar production data values are inconsistent among divisions and offices.

The organizational structure and relationship between the Finance Center and the Marine Corps Central Design and Programming Activity increases the difficulty of defining a valid and meaningful measure of automated systems enhancement efforts. The System Management Division (SMD) of the MCFC is the system sponsor for all of the automated disbursing systems. The division personnel receive, review, approve and then recommend all changes to the program(s) code and system(s) information flow prior to implementation. The approved recommendation for change (and supporting documentation) is then routed to the Programming Division of MCCDPA for analysis and program change (actually coding the program changes). MCCDPA then responds with a yes or no on whether they can accomplish the requested task, and provide a projected completion data. After completion and testing of the program change, it is scheduled into one of the semi-annual test cycles for field testing at various processing centers around the world. After successful test cycle implementation, the program change actually takes effect Marine Corps wide. Partially due to this extended implementation cycle, and lack of control by the System Management Division over the programmers and coding effort, a measurement of automated systems enhancement was difficult to identify.

A. ORGANIZATIONAL GOALS

The Marine Corps Finance Center has published and had approved from higher headquarters the goals and objectives which appear in Appendix A. These will be referred to as simply the goals from this point on. The primary points are briefly summarized below:

Ultimate Aim: Provide the best possible pay service to the active, reserve, retired and former Marine community. Improve and maintain the credibility and professionalism of the Marine Corps Finance Center.

Continuing, Ongoing Goals

1. Provide timely, accurate, responsive and effective disbursing system.
2. Enhance efficiency and effectiveness in managing Center resources.
3. Enhance the morale and welfare of the Center's employees.

"Front-burner" Goals

1. Develop, implement and maintain effective internal controls to assure that all Center resources and assets are safeguarded from fraud, waste and mismanagement.

2. Increase security awareness, identification, and resolution of security deficiencies.

3. Develop "measures of effectiveness" to monitor and evaluate the quality of Center operations.

4. Present proposed alternatives to accomplish functions and responsibilities of mutual interest to HQMC and MCFC.

The Thorndike dictionary defines goal as a, "thing for which an effort is made; thing wanted." An objective is defined as, "something aimed at. Something real and observable."

The MCFC goals are consistent with the definition of the word. An effort is made to provide accurate, responsive, effective disbursing service, and so on. The MCFC has never determined the method by which they will measure timeliness, accuracy, responsiveness, or effectiveness. This results in confusion and inconsistency since any two observers could conceivably come up with totally different definitions of the terms in the goals. For this analysis, the goals will be partitioned into a set of *objectives*. The objectives will be specific, quantifiable actions which can be evaluated as better or worse. The measure produced by combining specific production output data values (as defined by the individual objectives) will reflect overall improvement or decline in Center performance.

The Management Analysis Office (MAO) of the Finance Center has been tasked with defining objectives for the individual offices and divisions. The MAO has requested input regarding the definition of objectives from the offices and divisions which describe their function as it relates to the organizational goals. The initial responses from the divisions and offices were mostly general and could not be used to further define any quantifiable measures of command performance. This effort is ongoing and the author encourages the Finance Center analysts to consider combining the recommendations from this analysis with the efforts of the MAO staff to produce a more complete and detailed definition of the objectives. The Finance Center staff needs to clearly identify certain production efforts which can be measured and recorded to determine if their objectives have, or have not, been met. These measurements should tell the Commanding Officer whether or not the Center has done a better job then was done the previous month.

B. AUTHOR'S MAJOR ASSUMPTIONS

One major assumption made in this study is that one of the long term goals of the Finance Center is to more fully automate the pay process for all Active Duty, Reserve, and Retired Marine Corps personnel. This goal includes the "integration of information systems" (as defined in the Information Strategy Plan, ISP, for Manpower Personnel Administration and Pay). In the intervening period before the implementation of the REAL FAMMIS "umbrella concept", the Finance Center will continue to operate in a partially automated mode. In this sense the Finance Center exists to maintain and update the present automated systems, override and correct the existing data systems to ensure personnel are paid correctly and in accordance with applicable laws and regulations, and to assist Headquarters Marine Corps in the overall management and reporting of personnel and pay information requirements. Prime areas of concern for the center with regard to financial payments are:

1. Accurate payment of active, reserve, and retired Marines

2. Out of service debt

3. Prompt and efficient travel settlement

4. Personnel turnover in the Finance Center staff

5. Maintenance and updates to current automated systems

An additional assumption is that the Finance Center desires no additional data collection requirements beyond their current ones. While efforts of this analysis did require certain data items to be tabulated in a manner different than currently reported, no new data collection was required.

It is also assumed that the current command is not going to drastically change in size. This implies that the MCFC will not be receiving any significant changes in civilian or military personnel strength. The programming and operation of the present automated systems will remain with the Central Design and Programming Activity. The command's efforts to administratively support the Marine Corps Reserve Support Center and the Marine Corps Central Design and Programming Activity will not increase or decrease.

C. TEMPORARY OBJECTIVES

The remainder of this analysis is meant to help the Finance Center better define their objectives by looking at production output data. The selection of this data was based on previously defined goals, objectives, and assumptions given by the author. By projecting these into a set of definable objectives which can be measured, it is hoped that these few measures of effectiveness(known to be incomplete) will stimulate and entice the management and staff at the MCFC into thinking along these lines (quantitative and numerical) and provoke additional inputs into the objectives definition process for the Center.

From the defined goals, the follow-on recommendations for objectives, personal interviews between the author and all MCFC division and office managers, a set of objectives has been hypothesized based on the assumptions presented in the previous section.

The objectives defined in the following paragraphs are titled temporary because they are the author's recommendations and not the Finance Center defined objectives. While the majority of these objectives have been reviewed and agreed to by management analysts at the Finance Center, they have not been made part of any command policy or guidance.

1. Manual Interventions

The first objective is to improve the performance of personnel making manual corrections and updates to the automated systems.

The established goal of the Finance Center is to provide the best possible pay service to the active, reserve, retired and former Marine personnel. Accomplishment of this depends upon a variety of processes which include both automated and manual efforts. The majority of Finance Center personnel serve the functions of inputting, overriding, and correcting information; and monitoring and assuring the quality of the automated portion of the various pay and allowance systems.

One recommended temporary objective attempts to identify and summarize data which reflects overall Center performance of these manual efforts. While efforts were made to ensure the completeness of this data, it is recognized that it may not be inclusive, and any additional items which relate to the process of manually overriding and correcting the automated systems should be considered.

Measurement of these payment efforts should reflect the activity involved. The process will be fully automated after implementation of REAL FAMMIS. In the

meantime, efforts made to correct or update the automated pay cycles should be included in the measure of accurate payment. These efforts will be referred to as manual interventions. The objective is to improve the efficiency of the personnel making the changes and inputs to the automated systems.

The measure of this objective is broken down into four distinct subsections since the pay process is accomplished by four separate groups within the Finance Center. The manual updates to the automated systems are unique for active duty pay, reserve pay, retired pay, and the bonds and allotments processes. While the specific items measured have to vary, the concept of measuring manual efforts required to support the automated process remains consistent throughout the divisions. The retired pay system is almost completely manual, with very little of the current effort being categorized, measured, or recorded. Also, significant changes are being made to more fully automate the process. Due to these facts, no time was spent in analyzing the retired pay manual intervention category. When the automated system has been implemented and stabilized (this is expected in mid-late 1987) the Finance Center staff should follow the process used throughout this paper and complete a subsection of the manual interventions objective to measure the efforts of the Retired Pay Branch.

Attributes to be measured will be the production efforts accomplished divided by the office or division personnel strength. This will produce a measure of production per individual. The production efforts utilized for the measurement of each subsection are shown below and defined in Appendix B.

OBJECTIVE		DATA ELEMENTS
Manual Interventions	Active Duty	SupEnfTot
		InqCompl
		DaySpec
		CanChks
		EFTRtns
		TotTranInp
		TotTODES
		LvBalCor
		PayReconPro
	Reserve	Manpmts
		SpecPayOL
		TodInpOL
		ChkFrAutoCan

Bond/Allot	AddrChg
	ChksCanc
	BondRef
	RetroPay
	NoPostErr

2. **Travel Settlement**

The second objective is to improve the performance of the personnel who perform the travel settlement process.

Travel settlement efforts are currently being done by two different divisions within the Finance Center. Consolidated Disbursing Division (CDD) processes active duty personnel travel claims and Settlement Division performs the travel claim settlement process for retiring and separating Marines. The division's inputs to the MIR do not report this similar function in a consistent manner. This is because of the methods used by each division to report their on-hand, completed, returned, and delayed claims.

Settlement Division reports cases received (total), cases processed, and cases delayed administratively (returned or held for additional work). Consolidated Disbursing Division reports cases processed (the total is the same as cases received for Settlement Division), cases settled, and discrepancy notices issued (these relate to cases returned to the originator for additional work). In addition, Settlement Division reports cases on hand at start and end of month while CDD does not.

The measure for the objective reflects the volume of cases processed and completed by the respective Divisions. For Settlement Division this was the number reported in the MIR as 'cases processed'. For the Consolidated Disbursing Division this was the number reported in the MIR as 'cases settled'. These measures were divided by the appropriate division personnel strengths to reflect travel settlement production per individual.

Ideally, the measure would also include information on accuracy and timeliness of settled claims. This information is not available on a monthly basis (Quality Assurance Division's audit of Travel Vouchers occurs semiannually and results are available one to two months after the audit is done). The Command may want to consider utilizing the most recent audit percentages of correctly settled travel claims to adjust the current processed claims total for each subsection of measure of this objective. This would be easily accomplished by simply multiplying the processed

claims by the percentage of accurately settled claims determined by the QA division's most recent audit. This was not done for this analysis because of the long delay time between updates to this percentage and the author's belief that this does not provide a good incentive to the division or office managers.

3. **Separations Settlement**

The third objective is to improve the performance of the personnel who audit pay records for personnel seperating from the service.

No current method exists to monitor the timeliness of final settlement for Marines separated from active duty. Every record book is required to be audited, this is currently done in the Centralized Pay Division, Separations Branch. Any found in error, where the former Marine owes the government, are routed to Settlement Division for processing and collection. Settlement Division also receives requests from Marines who have been out of the service for some time and wish a review or clarification of some part of their pay.

The measure of this objective is simply to utilize the recorded cases processed by the Separations Branch, divided by the branch personnel strength.

4. **Out of Service Debt**

The fourth objective is to improve the performance of the personnel who notify and collect payment from seperated Marines for debts to the government.

The process of discovering an uncorrected overpayment, notifying Marines who have been separated from the service of their obligation to pay this debt, and then collecting that payment is an extremely sensitive and important issue within the Finance Center. It is also a difficult area in which to measure performance because of the extended time required to complete the process and the lack of control the Finance Center personnel have over a Marine who has been separated. However, this process can be effectively broken down into three phases. *Identification*, the first phase, includes the initial discovery of a debt situation and this was previously discussed in the Separations Settlement measure. *Notification*, the second phase, includes the initial correspondence being sent to the Marine to notify him of an obligation to repay the government some amount of money. *Collection*, the third phase, is less well defined and varies significantly for each individual case. It may include prompt repayment or it may extend over several years with requirements to reaudit the members record, accept partial payments over an extended period of time, negotiate a partial settlement, or completely write off the debt as uncollectable.

The second two phases of this process are measureable with current information the Settlement Division reports in the MIR. For purposes of this analysis the measures for both these processes has been combined into one aggregated measure of objective performance since they are done by the same personnel and relate to the same objective. This measurement combines measures of production output which reflect both out of service debt notification and settlement. These are then divided by the Settlement Division end strength to produce a measure of out of service debt recovery per individual.

5. **Automated Systems Enhancement**

The fifth objective is to improve the performance of personnel who update, modify, or expand the capabilities of the existing automated systems.

The Systems Management Division currently reports programming changes requested (of the Marine Corps Central Design and Programming Activity), changes completed (returned from MCCDPA but not tested), and changes pending (holding or being worked on by the MCCDPA). There is no available data on total changes requested from either the field units or local users of the systems. Neither is there any data on timeliness of changes that are made or on which automated system(s) are being modified. Comments and recommendations for improvement are made in Chapter 4. In the interim, the recommended measure of the objective is the number of changes submitted by the Systems Management Division divided by the SMD personnel strength. An increase in this figure represents an increase in the automated capability.

This is considered a much less than desirable measure and little significance should be placed on the resulting outcome. It should only be used until the Command adjusts their reporting requirements and begins collecting data which can provide more definitive and valid results for overall changes to the automated systems.

6. **Personnel Turnover**

The sixth objective is to increase the performance of managers for each division and office at the Finance Center in hiring and maintaining personnel at the 98% funded staffing level.

The measure of personnel assets can most easily be accomplished by measuring total on-board civilian personnel strength. The Command is funded at the authorized strength level of 98% of officially recognized billets. Since the civilian labor force comprises 89% of the overall command strength, it is adequate to monitor only

this one indicator of personnel levels and to allow military personnel strengths to be reported and dealt with on an exception basis. Civilian personnel strengths are currently reported in the Command's MIR and MAR monthly reports. These two reports do not always agree due to the methods used to update each one. The MIR is updated with a monthly submission of summarized data which has been retrieved from the Navy Civilian Personnel Data System (NCPDS). The MAR is updated on an *ad hoc* basis as personnel turnovers occur. This is accomplished by routing copies of the individual personnel assignment and transfer forms to the Management Analysis Office. The inconsistency of these two reports needs to be addressed by the Command. Where inconsistencies existed during the months being analyzed, corrections were made after confirming the results with personnel involved with both reports. The measure of this objective would be the recorded civilian personnel employed each month divided by the authorized staffing level.

Once the objectives have been established, the specification of production output data which measures performance relative to these objectives is needed. The next chapter will examine data the Finance Center is currently collecting in an attempt to determine if it is applicable toward measuring effective performance.

III. DETAILED DATA ANALYSIS AND MOE COMPARISON

A. INITIAL DATA REVIEW AND SELECTION

The abundance of information available to the author for review during the analysis was a bit staggering. The MIR contains over 635 different categories of information, each of which reflects some aspect of the operation at the Finance Center. In addition, the command is required by federal regulations and orders to maintain records which account for all funds disbursed. Recent concern throughout DOD in reference to fraud, waste, and abuse has created additional reports. Finally, the MCFC (as one arm of the Fiscal Director, Headquarters Marine Corps) routinely deals with requests from the legislative branch, other government agencies, and other Services in the Department of Defense. In the work reported here, it was possible to examine only a small percentage of this large amount of data.

Desirable properties of a measure of performance are as follows. [Ref. 3: page 50]

- It should be complete. This is to indicate that the attributes or production output data values which are recorded are adequate to determine the degree to which the overall objective is met.
- It should be operational. The measured production output data values must be meaningful to the decision maker so that they can understand the implications of the measure.
- It should be decomposable. The measures can be broken down into parts of smaller dimensionality and these subparts should reflect (if possible) production factors in keeping with the objective.
- It should be nonredundant and minimal. Measures should be defined to avoid double counting of consequences, yet should be as compact as possible to keep the scope of the analysis reasonable.

The initial selection of data to be examined was done by examining the temporary objectives and discussing these with the Commanding Officer, Executive Officer, and senior division and office managers. It was concluded that a combination of the information contained in the MIR, MAR, NCPDS, the Fund Administrator Status and Performance reports, and certain selected division and office reports consistently represented enough information to indicate an increase or decrease in Center performance.

The MIR was examined in detail (line item by line item). Data which reflected no relevance to the temporary objectives was immediately discarded. Examples of these are local reproduction operations, payments by electronic fund transfer (direct deposit), amounts of disbursements for pay, and incoming or outgoing mail distributed.

The MIR has been produced for the last several years, however, format and information content has periodically changed. An additional reduction of data, used in this analysis, was made when it was discovered that several of the items deemed critical to the overall measure of performance were either missing or recorded in different formats previous to July 1985. For these reasons, data from June 1985 and earlier was rejected and not included in the analysis effort.

The remaining production output data categories were listed and interviews with the applicable division or office managers were conducted. Items which related to specific office functions were agreed upon, by that manager, as to their "intuitive correctness or incorrectness" as a measure. These were then examined in more detail to determine their distribution characteristics and their interaction with the other production output data values being combined into the measure for each objective.

B. INDIVIDUAL PRODUCTIVITY

The problem of utilizing only production output data, as it is recorded in the MIR, in a measure of effectiveness is that no information can be gained on the cost (in individual effort or dollars) of producing the product. If a measure such as the current one goes up, there is no knowledge if the work force has really done a better job or if there were simply more workers involved in the production effort.

One solution to this problem would be to account for each and every dollar spent by a section (for both personnel and resources). This cost information could then be used to estimate a cost per item produced. Unfortunately, in this application, the Finance Center accounting and budgeting office reports cost information in categories which are either too general or too incomplete. The effort involved in reducing this information to the office or division level was considered impractical and alternatives to this were examined.

An alternative was to use the overall division or office personnel strength for the production output data being measured. The production data value was then divided by the personnel strength for each month and this allowed a rough approximation of average individual effectiveness. The reported values can be considered to represent the number of items produced per individual in the section per month. This is known

to be only a very rough approximation since not all individuals in any section apply their skills to producing each measured item. The Finance Center is encouraged to develop better breakdowns of the personnel assets required for each objective production output value being measured. The monthly production output data values are combined into a measure of effectiveness for each objective. These performance measures for each objective are then aggregated to develop the overall measure of effectiveness for the MCFC.

C. GRAPHICAL AND STATISTICAL ANALYSIS

The production output data sets were examined with a combination of simple graphical techniques such as scatter plots and time series plots. These graphs are very useful in determining approximate distributional information and in detecting major trends in the specific data. These techniques are also useful because they allow the analyst a quick, concise overview of each specific data set without being forced to page back and forth through 10 different monthly MIR reports.

The desire is to remove any production output data values from the measure of effectiveness which would influence the overall measure to a greater degree than they should. This might be the case if a production output data value was normally in a specified range but, due to the months which were chosen for the analysis, the recorded results were extremely high or low. It is desired to observe these outliers before the measure of effectiveness is computed so they could be eliminated from the computation of the mean and standard deviation.

Significant results of this portion of the analysis are summarized in Table 1. It is assumed that obvious information such as high value, low value, mean, and standard deviation need no explanation.

The graphs displayed in Figure 3.1 and Figure 3.2 show a general upward trend in support enforcement totals and inquiries completed. These trends are not surprising to the analyst because recent court rulings have imposed a greater responsibility on all military finance institutions to enforce support payments. Due to the greatly increased reliance on direct-deposit and electronic fund transfer pay systems, the Finance Center must answer more inquiries regarding pay. Management for the Active Duty Pay Division should observe this increase and consider (based on requirements for overtime work) whether additional personnel would help the Division accomplish required work more effectively.

TABLE 1

PRODUCTION OUTPUT PRODUCED PER INDIVIDUAL PER MONTH

Production data	Mean	Min	Max	Std. Dev.
SupEnfTot	12.745	10.883	15.680	1.482
InqCompl	12.921	8.101	16.824	3.120
DaySpec	43.579	21.685	52.148	8.662
CanChks	40.359	20.719	55.611	9.194
EFTRtns	.905	.555	1.500	.295
TotTranInp	62.663	23.436	157.660	42.627
TotTODES	5.496	4.271	6.444	.696
LvBalCor	2.439	1.288	3.017	.490
PayReconPro	63.819	54.034	72.400	5.563
ManPmts	.749	.380	1.721	.401
SpecPayOL	23.821	10.855	68.231	17.952
TodInpOL	45.845	27.403	63.550	10.370
ChksFrAutoCan	17.201	3.028	49.594	17.405
AddrChg	54.192	43.333	68.645	9.591
ChksCanc	6.712	5.133	9.633	1.388
BondRef	.260	.033	.500	.154
RetroPay	1.597	.333	5.129	1.403
NoPostErr	136.399	60.032	308.290	80.955
CasesSettled	111.745	91.411	137.200	12.881
SettProc	37.987	29.000	47.416	6.677
CasesProc	87.13	62.69	138.11	23.51
CompCases	42.14	24.96	55.28	9.735
ChgsReq	.539	.271	1.102	.230
PersFactor	.965	.930	.989	.018

Note: Definitions of the shortened production data names are attached as Appendix B.

The graphs displayed in Figure 3.3, Figure 3.4, and Figure 3.5 show a noticable downward trend in TODES input online, special payments input online, and checks processed from auto-cancellation. This appears to be extremely significant to the measure of effectiveness for reserve manual interventions. While further analysis will follow on these data items, the reduction in the number of manual interventions indicates an area the management of the Finance Center should investigate much more closely. Due to the limited number of production output values (only 4) being measured, the effectiveness measure can be expected to decrease. The Finance Center could use fewer personnel in the Reserve Pay Division to increase the measure of effectiveness. If the Reserve Pay staff is truly being productive, then it is believed additional production outputs need to be identified and included in the measure of effectiveness.

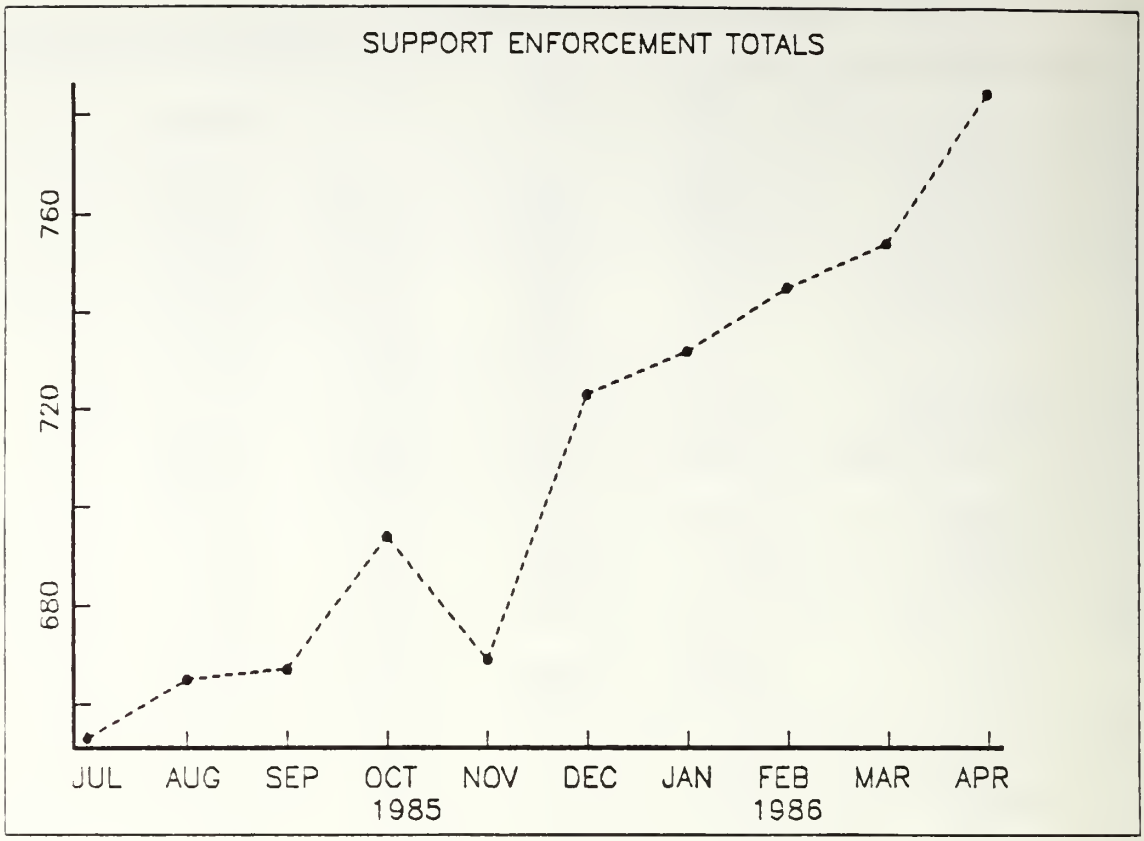

Figure 3.1 Plot of Support Enforcement Totals, July 1985 - Apr 1986.

D. CORRELATION COEFFICIENT

The correlation of two data values is defined as the covariance of the data values divided by the product of the data value's standard deviations. This measure is denoted Rho (ρ). The covariance is defined as in equation 3.1 below.

$$\mathrm{Cov}\{X_i,X_j\} = E\{(X_i-\mu_i)\,(X_j-\mu_j)\} \qquad \text{(eqn 3.1)}$$

The correlation coefficient is a measure of association between two variables which is bounded between -1 and +1. The computation of the correlation coefficient is as defined in equation 3.2 below.

$$\rho = \frac{\mathrm{Cov}\{X_i,X_j\}}{\sigma_i\sigma_j} \qquad \text{(eqn 3.2)}$$

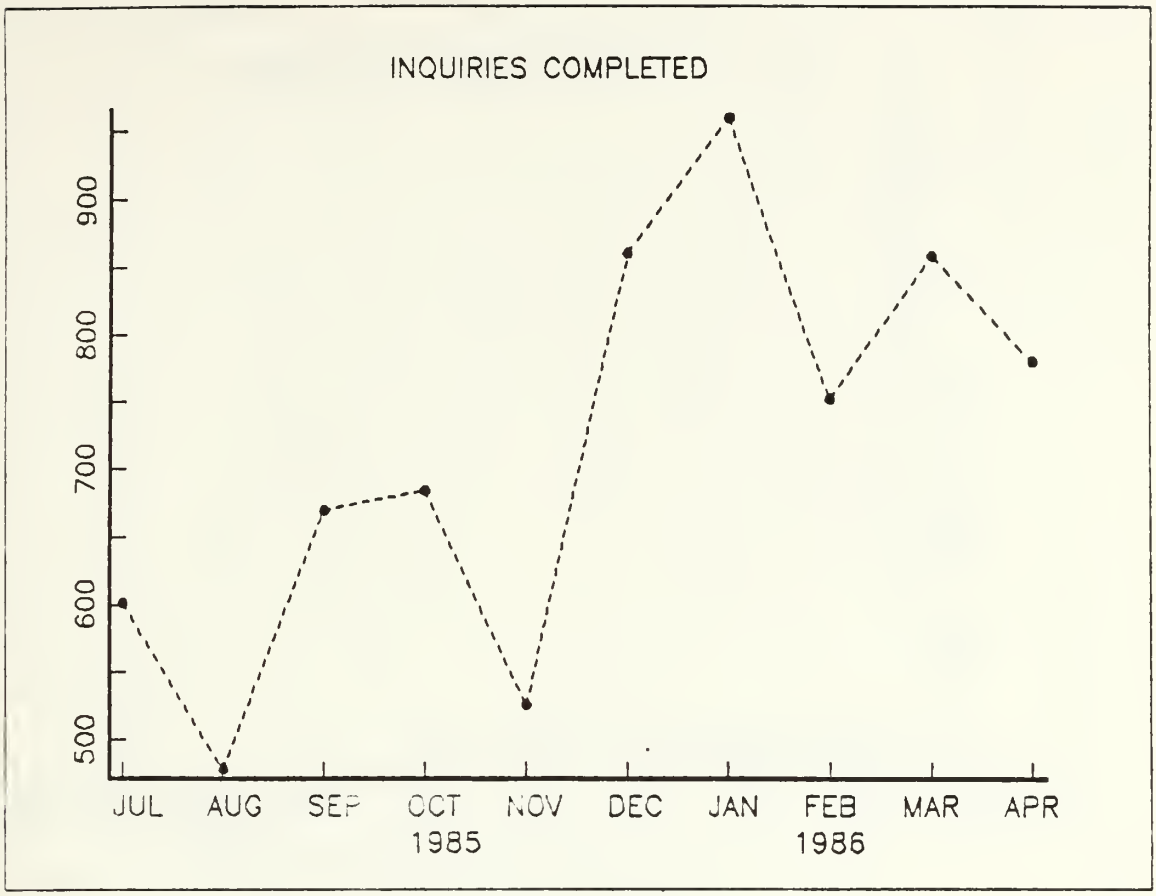

Figure 3.2 Plot of Inquiry Completions, July 1985 - Apr 1986.

This value can be, at maximum, a value of 1. This would mean the points must lie on a straight line and the value for X_i is completely determined by the value for X_j (or vice versa). [Ref. 4: page 257]. This is a standard statistical measure of the degree of association between variables. This value can be from -1 to 1 and the closer it is to zero the weaker the correlation between the variables. The closer the ρ value gets to 1, the stronger the correlation between the variables. A negative correlation is one where one of the production output values get higher as the other values get lower (and the reverse). A quick plot (or examination) of the data points can help determine if the correlation is positive or negative.

The correlation coefficient is quite useful in determining if there is a direct connection between the two production output values. This connection could be a positive or negative correlation. The knowledge of this association is desired from an analytical viewpoint to help determine if any of the production values can be used as

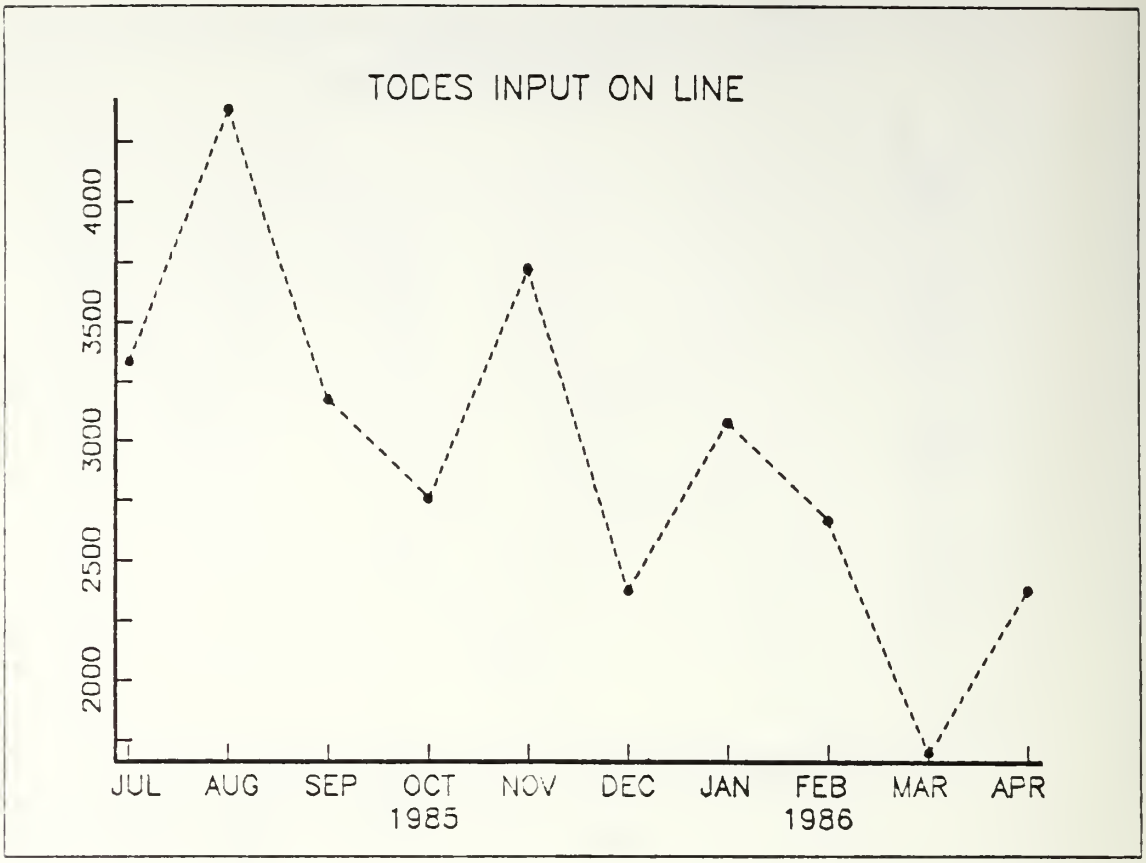

Figure 3.3 TODES Input Online, July 1985 - Apr 1986.

indicators for other production values. It is desired from the management viewpoint to examine and observe a relationship between two related functions of the organization. More knowledge of this association allows for better decision making.

The results of all correlation calculations are not shown. This information is summarized in Tables 2, 3, and 4. These tables are for the manual intervention production output values relative to their subsets. The value represented in the table is the correlation coefficient value (ρ) for each association between production output data values. As can be quickly seen by scanning the tables, correlations are mostly less then a value of .85 and this is considered significantly small to be ignored in this application. The value of .85 was chosen for a cutoff because of the increased possibility for error due to the small sample size (only 10 data values for each production output category were used to estimate the mean and standard deviation). The two exceptions to this are the combination of the "special payments online" and

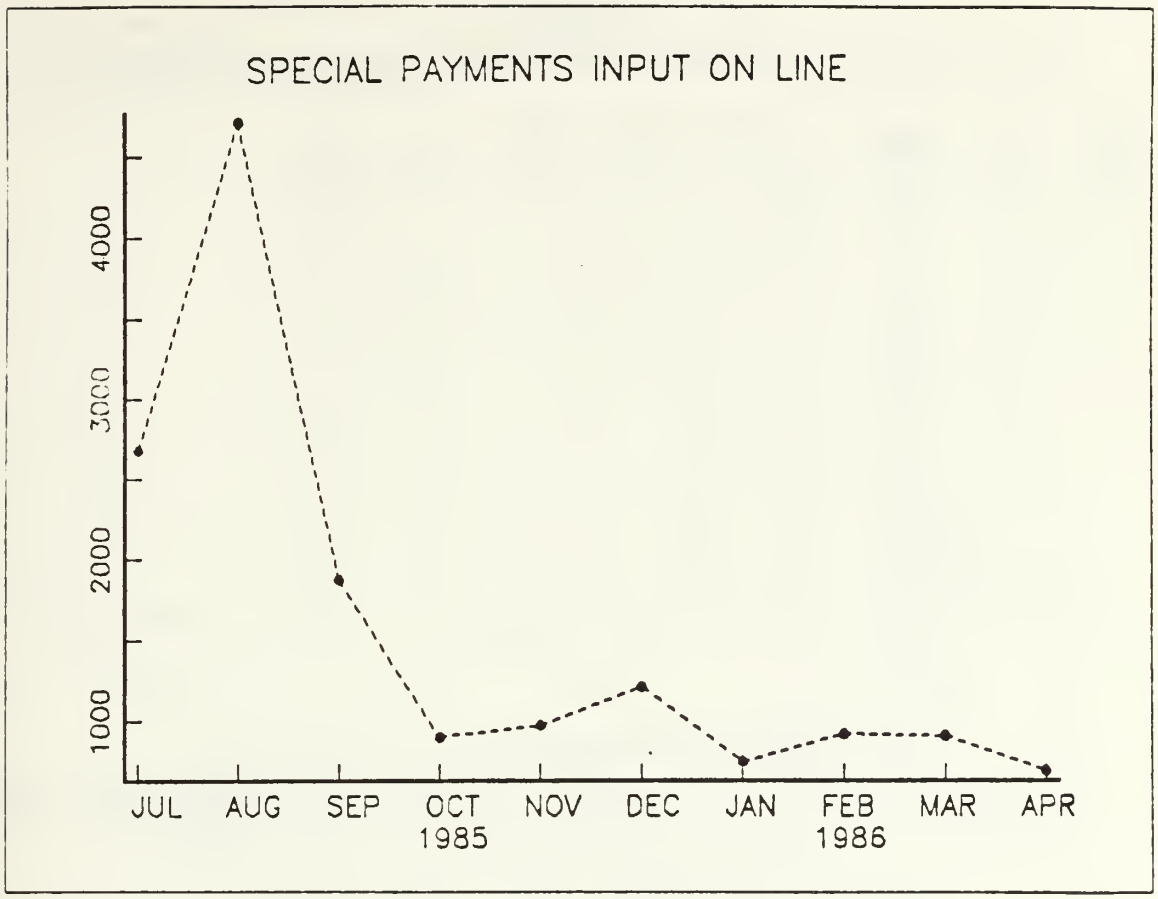

Figure 3.4 Special Payments Input Online, July 1985 - Apr 1986.

"checks from auto cancellation" (ρ = .91) and the "address changes" and "bonds refunded" (ρ = .88).

These four production values were examined in much greater detail after determining that they may be related. Many times, when someone sends the Finance Center a change of address, it arrives with a request for savings bonds to be refunded. Likewise, when checks are cancelled through the automatic process in error, it often requires additional action on the part of Finance Center personnel to make a special payment to offset the erroneous cancellation. Production output data values with a very high correlation are usually examined to avoid making a "double-counting" type of mistake where a similar action is being counted twice while only being performed once. This is not the case with any of these 4 production output data values because separate personnel are required to perform different tasks. Because of this, it is considered appropriate and necessary to leave these individual measures in the final measure.

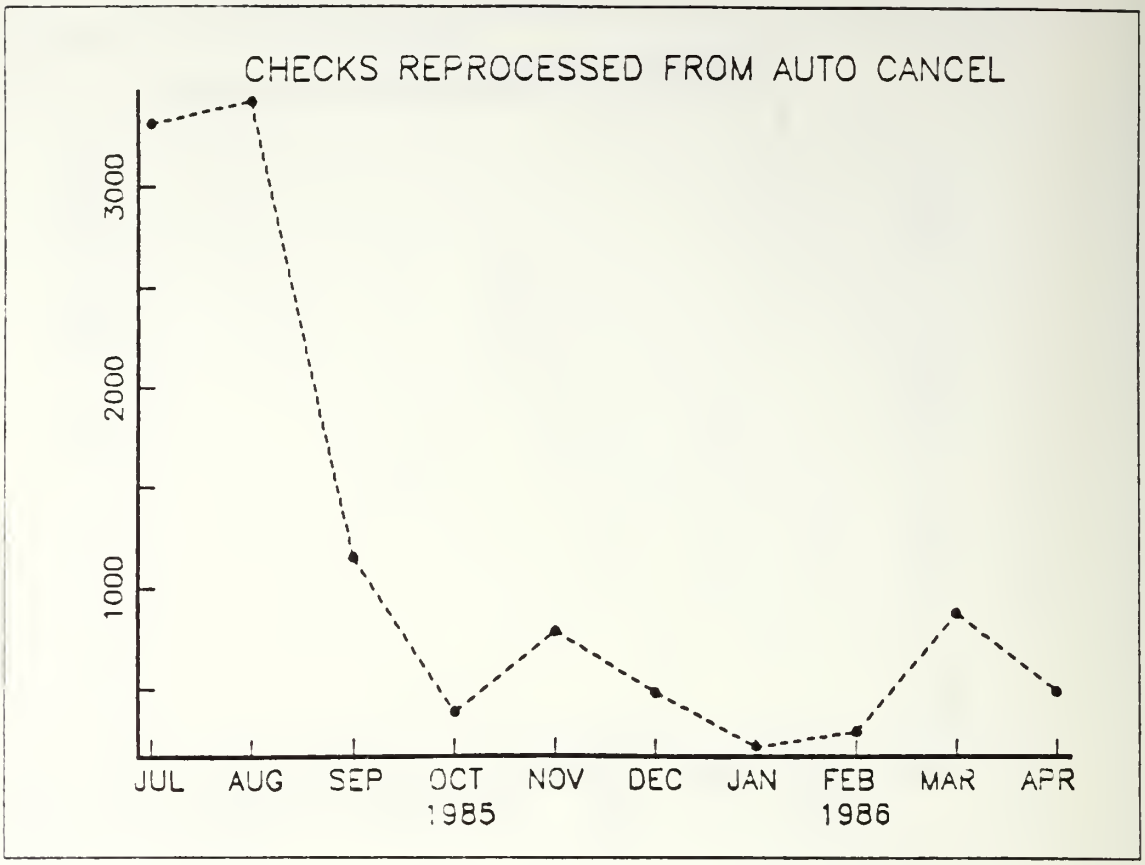

Figure 3.5 Checks from Autocancellation, July 1985 - Apr 1986.

E. SUMMARY OF DATA ANALYSIS

It should be noted at this point that the preceding analysis has not allowed any firm conclusions toward the development of a measure of effectiveness. Rather, with regard to the defined temporary objectives, the analysis is performed in a manner to eliminate production output data value outliers from consideration as measurement indicators for the objective. These production output data sets are determined to be either trivial (relative to other items which can measure the same objective) or repetitive. Their inclusion in the measurement of the objective would allow little, if any, gain and would require the added cost and effort of continual data gathering. In this analysis, no production output data categories were eliminated. This was due to the limited number of production values being measured. The concept is to allow management and the analyst to know as much as possible about the distribution and

TABLE 2

CORRELATION: ACTIVE DUTY PAY, MANUAL INTERVENTIONS

	Sup Enf Tot	Inq Comp	Day Spec	Can Chks	EFT Rtns	Tot Tran Inp	Tot TODE	Lv Bal Cor	Pay Rcon Pro
SupEnfTot	1.00	.77	-.21	-.25	-.16	.79	.20	.36	.60
InqCompl	.77	1.00	-.38	-.38	-.40	.49	.62	.65	.63
DaySpec	-.21	-.38	1.00	-.33	.29	.15	-.41	-.34	0.0
CanChks	-.25	-.38	-.33	1.00	.02	-.04	.02	-.24	-.43
EFTRtns	-.16	-.40	.29	.02	1.00	-.20	-.54	-.44	-.45
TotTranInp	.79	.49	.15	-.04	-.20	1.00	.13	.23	.49
TotTODES	.20	.62	-.41	.02	-.54	.13	1.00	.76	.20
LvBalCor	.36	.65	-.34	-.24	-.44	.23	.76	1.00	.51
PayReconPro	.60	.63	0.0	-.43	-.45	.49	.20	.51	1.00

TABLE 3

CORRELATION: RESERVE PAY, MANUAL INTERVENTIONS

	Man Pmts	Spec Pay OL	Tot Inp OL	Chkfr Auto Can
ManPmts	1.00	-.08	-.32	-.16
SpecPayOL	.08	1.00	.64	.91
TodInpOL	.32	.64	1.00	.53
ChkFrAutoCan	.16	.91	.53	1.00

behavior of the production output data values before the actual measures of effectiveness are computed.

The final decision of which production output data values are selected for computation of the MOE(s) should remain with the management of the Finance Center. They are the personnel who know the most about their organization and its required functions. The analyst can not be expected to be as intimately familiar with the day to day requirements of the operation as the personnel who have been working in the unit for years.

TABLE 4

CORRELATION: BONDS & ALLOTMENTS, MANUAL INTERVENTIONS

	Addr Chgs	Chks Canc	Bond Ref	Retro Pay	No Post Err
AddrChgs	1.00	.32	.88	.37	-.05
ChksCanc	.32	1.00	.29	.21	-.10
BondRef	.88	.29	1.00	.28	.27
RetroPay	.37	.21	.28	1.00	-.07
NoPostErr	-.05	-.10	.27	-.07	1.00

F. MEASURE OF EFFECTIVENESS COMPARISON

The following production output data values will be used to measure improvement in the defined objectives. These measures of effectiveness for each defined temporary objective are aggregated to form the overall measure of effectiveness for the MCFC in the sections which follow. They are as seen in Table 5.

The objectives are equivalent to multiple measures of effectiveness. The aggregation of multiple MOE's into a single MOE has posed problems for researchers and managers for many years. It is not an easy problem, nor is it totally solvable. Of the known methods for aggregating MOEs, all have advantages and disadvantages.

A brief discussion of many different methods for attempting to solve this problem are included in Appendix C. The author chose to use the weighted-linear method and the weighted-product method because they are believed to be significantly accurate while still being relatively simple to calculate and easily understood. In addition, these methods are both easily implemented at the Finance Center with the current software and reporting requirements.

For brevity in discussing these two methods to aggregate multiple measures of effectiveness the following terms and notation will be used. A subsidiary set of "n" different MOEs (M_1,M_2, ... ,M_n) exist and the desire is to aggregate them into a single, overall MOE (this will be denoted by E). Weights for each individual MOE will be indicated with w_1, w_2, ... , w_n.

1. The Weighted-Linear Method

The advantages of this method are as follows:

- It is simple, straightforward, and may be easy to understand and explain.
- No data is needed, except the weights, to build the mathematical relationship.

The disadvantages of this method are as follows:

TABLE 5

OBJECTIVES AND COMPONENT PRODUTION OUTPUT VALUES

OBJECTIVE		PRODUCTION VALUES
Manual Interventions	Active Duty	SupEnfTot InqCompl DayShpc CanChks EFTRtns TotTranInp TotTODES LvBalCor PayReconPro
	Reserve	Manpmts SpecPayOL TodInpOL ChkFrAutoCan
	Bond/Allot	AddrChg ChksCanc BondRef RetroPay NoPostErr
Travel Settlement		CasesSettled SettProc
Separation Settlement		CasesProc
Out of Service Debt		CompCases
Automated Enhancements		ChgsReq
Personnel Turnover		OBStrgth

- It is an average of the individual MOEs.
- It does not provide a diminishing marginal rate of return with respect to the M_i's (the second derivative is 0 as opposed to being less then 0).
- Dimensionality problems may exist since the individual MOEs are in different units.
- No consideration of variance or uncertainty is accounted for in the model.
- Model is extremely scale dependent. One MOE which works in units of thousands would have a tendency to overwhelm and dominate another MOE whose unit of measure was tens.

The weighted-linear method is defined so that the overall Measure of Effectiveness is an addition of the weighted, individual MOEs as shown below [Ref. 3: page 64] in equation 3.3.

$$E = w_1 \times M_1 + \ldots + w_n \times M_n \qquad \text{(eqn 3.3)}$$

$$= \sum_{i} w_i \times M_i \qquad (i = 1,\ldots,n)$$

The M_i's can themselves be composed of multiple, aggregated measures of effectiveness. They are, in this application, for the objectives of Manual Interventions and Travel Settlement. The subcategories of the M_i's are computed in exactly the same manner as the objective measure.

2. **Normalization of Production Output Data**

Each individual production output data value should first be normalized. This removes the vast majority of scale and variance problems associated with the linear method and allows the production output data values to be considered equal values with a common dimension. This common dimension can be considered a measure of the degree of variation from the expected value (mean) relative to previously observed months. This is accomplished by taking each production output measure, subtracting the previously computed sample mean (μ) for that production output (PO) data value, and then dividing the result by the computed sample standard deviation (σ). The values used for μ and σ are shown in Table 1.

$$\text{Normalized } PO_j = \frac{PO_j - \mu_{po}}{\sigma_{po}} \qquad (j = 1,\ldots,m) \qquad \text{(eqn 3.4)}$$

The index of j is used to indicate the number of months. For most situations, and the Finance Center's monthly use, this value would only be 1. The value of m for this analysis is 10 because 10 months of data are being compared and 10 different aggregated measures are being computed.

These normalized values are then used in the computation of the M_i's. The M_i's are computed exactly like the aggregated measure E. The individual production output values for each objective performance measure are normalized, summed, and divided by the number of output values. This is because the weights are equal for this analysis. Since the production output values have been normalized, their values will be both positive and negative numbers. The mean of these normalized values will be zero. This can be most easily interpreted as having produced the average or expected amount of the product per worker. A negative value indicates production below the mean and a positive value indicates production greater then the mean.

For the purposes of this analysis, the weights have all been left equal. The equality of weights approach has some merit (i.e., all functions of the organization are equally important and should contribute to the overall accomplishment of the mission equally). Still, the MCFC should decide if this is in keeping with their judgement on the efforts and importance of each production output value or objective measure, relative to the overall measure of effectiveness of the Finance Center.

a. Computation Example

A sample computation of one of the measures will help the reader understand the methodology used.

After each production output data value is normalized, the values are weighted and then summed. Since the weights are equal in this example, the process may be simplified to summing all the normalized values relevant to the manual interventions objective, and then dividing by the number of output values. For the month of July 85 the result is as shown below:

Production Output Category	Normalized Value
SupEnfTot	-1.256
InqCompl	-.930
DaySpec	.858
CanChks	.88
EFTRtns	-.864
TotTranInp	.357
TotTODES	.341
LvBalCor	.124
PayReconPro	-.599
ManPmts	-.107
SpecPayOL	.868
TodInpOL	.310
ChksFrAutoCan	1.808
AddrChg	.937
ChksCanc	.053
BondRef	1.558
RetroPay	-.374
NoPostErr	1.405
Total sum =	5.369

Final value for M_1 for July 1985 = 5.369/18 = .2982

This process is continued in the same manner for each separate M_i. The M_i's are then weighted and summed. Again, since the weights are being kept equal for the M_i's the six different objective measures can be summed and divided by 6. For July 85 the results are as shown below:

M_1	.298
M_2	-.139
M_3	-.713
M_4	-.834
M_5	2.448
M_6	-.155
Total sum of the M_i's =	.903

Aggregate MOE value for MCFC for July 85: E = .903/6 = .1505

3. **The Weighted-Product Method**

One other method commonly utilized is the weighted-product method. It has the advantage over the weighted-linear method in that some indication of diminishing marginal returns do exist for the individual M_i's as long as the weights are kept between $0 < w_i < 1$. This is generally acknowledged as more realistic. This model implies that a person would not be equally happy giving up a fixed amount of some product X for a gain in a fixed amount of some product Y throughout the entire possible range of values for both X and Y. As more and more of X was accumulated, a varying (decreasing) amount of Y would be considered an appropriate exchange. A more in-depth look at this subject can be found in almost any elementary Economics text.

This method suffers the same disadvantages as the weighted-linear method in that it is still nothing more than an average of the data. The difference is that the data was first logged and then averaged in the weighted-product model. This difference, in the resulting aggregated measure, can be seen numerically in Table 6 and graphically in Figure 3.6.

Computation of these values proceeds exactly as shown in the example above except the data values are first normalized and then a constant value of 4 is added to each production data value. This is done to allow the computation to be done with the log natural function (since it is only defined for values of 0 or greater). These adjusted values are then summed and divided in exactly the same manner. When the

computation is complete, the result is raised as a power of e (e^X) and the constant value of 4 is subtracted to produce the actual measure of effectiveness.

The weighted-product method is defined so that the overall MOE is a product of the weighted, individual MOEs [Ref. 3: page 118] as shown in equation 3.5.

$$E = (M_1)^{W1} \times \ldots \times (M_n)^{Wn} = \prod_i (M_i)^{Wi} \qquad \text{(eqn 3.5)}$$

$$\ln E = \sum_i (w_i) \times \ln (M_i) \qquad (i = 1,\ldots,n)$$

Table 6 shows the aggregated measure computed for both models for each month. The reader can easily observe the fact that the numeric value computed for each method is not the same.

TABLE 6
MONTHLY COMPARISON OF LINEAR AND PRODUCT MODEL RESULTS

	Weighted Linear Method	Weighted Product Method
July	.1505	.1738
August	.1882	.2726
September	.2083	.3833
October	-.0904	.0145
November	.3543	.5587
December	.1093	.2781
January	-.0347	.0434
February	-.7608	-.7139
March	-.0855	.0226
April	-.0185	-.0593

In comparing the results of the weighted product and weighted linear methods for aggregating MOEs it should be noted that the results are consistent in their evaluation of effectiveness (higher or lower) between the two methods in nine out of

the ten months used in the analysis. The absolute number varies between the two models, but the change from lower to higher (or the reverse), is consistent between the methods. By examining the change in overall MOE value between the months of March 1986 and April 1986, it will be observed that an inconsistency exists between the evaluation given by the two models.

The overall MOE changes relative to changes in standard deviations of the individual MOEs (M_is) as shown in Table 7. This sensitivity to a change of plus or minus 1 standard deviation (σ), or more, in a single M_i is compounded, or decreased, when combining multiple MOEs. The results, on the aggregated measure, of a change in a single M_i (while holding the remaining five M_i's constant) are as seen in Figure 3.6. This result is also seen in the E values computed for the months of March and April in Table 6.

TABLE 7

COMPARISON OF CHANGE IN A SINGLE MEASURE TO OVERALL E

	-3σ	-2σ	-1σ	1σ	2σ	3σ
Linear Method	E = -.5	E = -.333	E = -.1667	E = .1667	E = .333	E = .5
Product Method	E = -.825	E = -.436	E = -.187	E = .151	E = .279	E = .391

The degree to which this inconsistency affects an organization using one of these methods varies as well. If the organization produces, on a fairly consistent basis, the same quantities of items X, Y, and Z each and every month, they may desire an overall measure which is more sensitive to a large change (relative to the normal). If an organization produces a continuously varying amount of items X, Y, and Z, they may prefer an overall measure which does not react to these variations quite as drastically. The first organization would probably prefer the weighted-linear method, the second the weighted-product method. This inconsistency can be reduced or compounded by changing the weights on the measured production values or objectives in computing the overall measure of effectiveness.

The major point is that there does exist a problem with any measures of effectiveness that exhibit such inconsistencies. The Finance Center should be aware of this fact before they accept either of the two methods and know the possible differences which could arise. This does not imply these two methods are invalid or unworkable, it does suggest that neither of these two methods is a perfect answer to

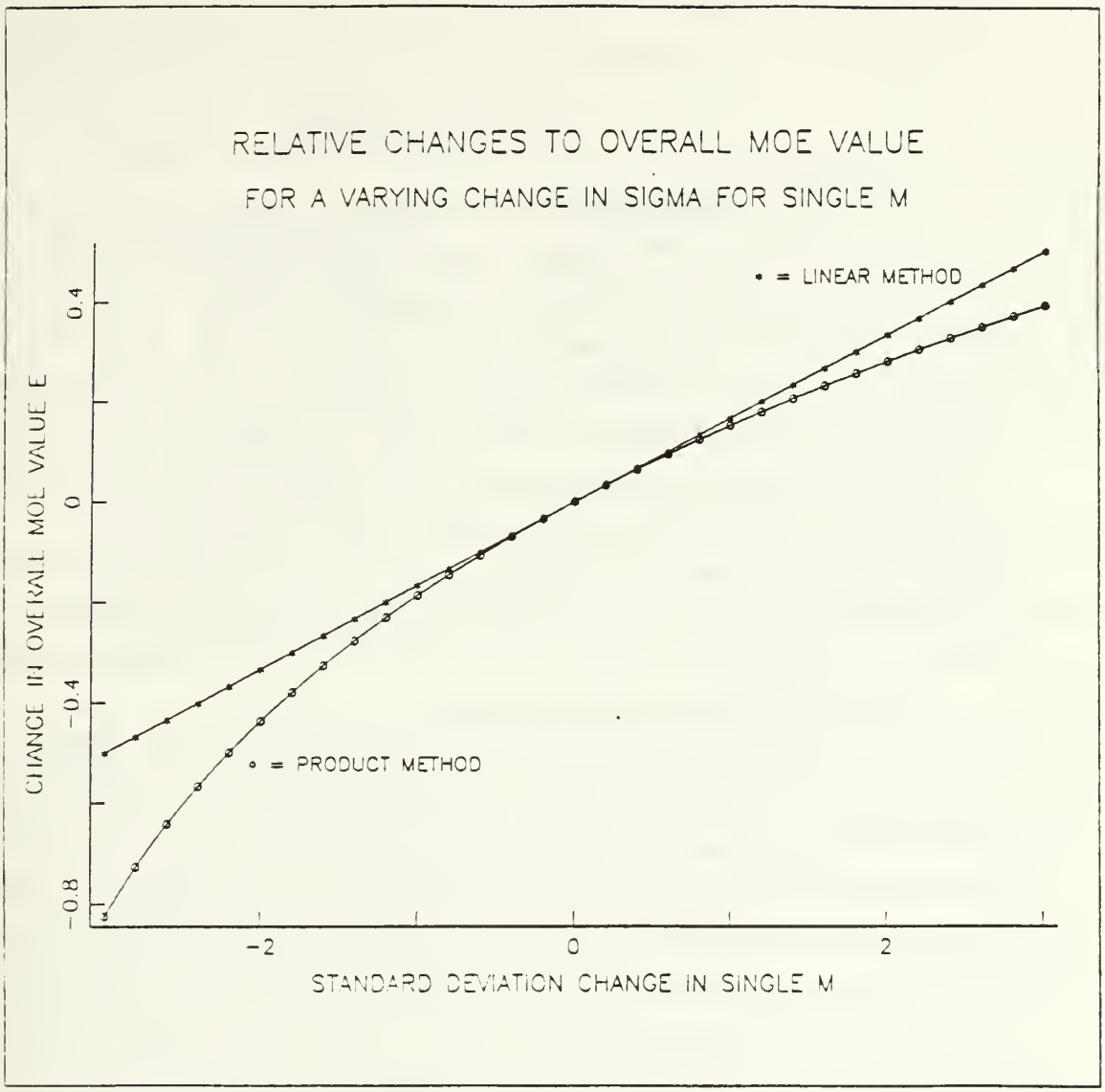

Figure 3.6 Plots of Linear and Product Method Overall Results.

the organization's problem. The only two methods known to solve this inconsistency are the Dominance criterion and the Utility Theory Multiple Attribute Decision Making (MADM) approaches. The MADM method does not solve the problems completely. It does require a good deal more analysis and input from key personnel at the Finance Center. However, it delivers far more consistent results because the decision criterion have been converted to a scale of similar measure prior to the aggregation of the MOEs. These methods are both discussed in Appendix C of this thesis.

IV. CONCLUSIONS

A. CONCLUSIONS RELATING TO FORMULATING OBJECTIVES

The Marine Corps Finance Center cannot measure effectiveness of the organization without first agreeing to quantifiable objectives. This point has been stressed throughout this paper and remains the keystone to any future work devoted to this subject. While it is important that the production output data chosen to make up the measure of the objectives be carefully selected, this should not restrict members of the Finance Center staff from choosing any data categories they feel should be included in a measure of Finance Center performance. As long as the production values utilized in the measure are fixed for a reasonable length of time (say nine months to a year), then there is no reason management can not decide to change these as the organization evolves.

Estimating the mean and standard deviation (which is essential to the normalization process) requires data to be gathered in advance of its implementation in the measurement process. Because of this, the Finance Center should seriously consider using more production values in the beginning of the process. As experience with the measurement process is accumulated, elimination of the superfluous data elements may be accomplished. Removing a data category from the measure is quicker and easier then adding new categories. The point to stress during the initial stage is the agreement and implementation of a measurement process. This would mark a significant change from the current operation and needs to be completed to realize the full potential of the Center's staff as they progress to a more fully automated and integrated system.

The principle problem with all the defined temporary objectives is this analysis' treatment of individual productivity. The concept of determining the production to personnel ratio is crucial to the Finance Center's goal of measuring and improving performance. Identification of the correct production output values to completely measure improved, or decreased, performance has been emphasized repeatedly. It is just as important to recognize that the same importance should be placed on accurately recording the personnel assets used to accomplish these production efforts. The Finance Center staff should devote an equal amount of effort in determining the

personnel assets required for each measurable attribute. The more accurate this information, the more accurate the measure of performance and the greater its value to the Finance Center.

Additional problems with certain specific measurements have been noted throughout this paper. A quick review of these problems, the severity of each, and some recommendations for correction and improvement are included below.

The measurement of manual interventions is lacking any information on Retired Pay Division efforts. This was done because current methods of recording the performance efforts of this division are not formalized or reported. This is a significant gap in the overall measure of manual interventions and should be corrected as soon as possible to allow the Finance Center a more complete measure.

The measurement of travel claims settlement is considered to be a good measure of the effort being produced by the Travel Settlement Branch, Separations Division and the Active Duty Pay Division. The requirement to accurately identify the personnel involved in each respective section needs to be addressed and corrected. This is considered to be an important correction, especially if any desire exists to compare the results of the two separate sections. The previously mentioned "accurately settled travel claims" would be a desirable measure to record, but the current method used to audit and record accuracy levels (every six months) may be a restriction to using this measurement method. The Command should examine the additional benefit they feel would be gained against any possible detrimental effects of leaving the sections handicapped or improved by good accuracy performance, on the previous audit, for the next six months of operation.

The measurement of automated enhancements is, at best, weak. There are no current measurement efforts reported or made to record information on which system or computer program was changed, how much effort was involved in the change, whether the change was made to correct a problem with the system design or was made to enhance the system because of new requirements, etc. The author believes this is a very critical requirement to arrive at an accurate and meaningful overall measurement of the Finance Center's performance. The importance of this area of the Center's operation will increase dramatically over the next few years. The Finance Center's mission will change (albeit subtly) as the implementation of the REAL FAMMIS concept becomes a reality in the 1990's and it is expected the measures of the successful accomplishment of the mission will change and evolve likewise. Only the

sparsest information is available to examine or report on any kind of automated systems enhancement objective. In addition, the ability to determine which personnel worked on which project(s) is not present. The author recommends that Systems Management Division begin reporting and maintaining data to reflect at least the following information:

	AUTOMATED SYSTEM			
	JUMPS/MMS	REMMPS	RPPS/DOV	OTHER
Number changes requested by user				
Number changes approved for implementation				
Number changes submitted to CDPA for prog.				
Number changes completed pending testing				

This analysis has not examined any measurement for Support Operations. This was intentionally done because the objectives for this important function were either not identifiable or not measureable. The Command should review this area for concrete objectives which can be measured and recorded. The overall measurement is incomplete without this portion. In the meantime, the aggregated MOE values calculated for this paper can be considered the measurement of the Financial Operations of the Finance Center. After developing a similar measure for Support Operations, the two should be combined to achieve an overall Finance Center MOE.

The data gathering techniques emphasized at the Center need to correct these deficiencies. In addition, data needs to be available for each Division Office head on personnel costs and overtime costs. As is the case in most cost benefits studies, it is extremely difficult to identify the results of the benefits without knowing the cost. The majority of the Finance Center's budget is expended for personnel costs and these personnel assets need to be recorded on a level below the current cost code breakdown available from the accounting and budget office. Improvements in these areas would generate the greatest benefit to any future analysis and to the definition of valid and meaningful measurement of performance.

B. CONCLUSIONS RELATING TO FORMULATING THE OVERALL MOE

The specific advantages and disadvantages of utilizing the weighted-linear or weighted-product methods were discussed in Chapter III. In addition, the overall approach of normalizing (or standardizing) the original data has some problems. Normalization is required to eliminate scale differences in the attribute measures and to control some of the effects on the measures vastly different variances. Likewise, the data are no longer ratio type data and comparisons such as "April's measure is 20% greater or lesser then March's measure" are erroneous and should not be made. The comparison of differences between multiple months (such as March to April shows a .067 improvement for the weighted-linear method as compared to Feb to March showing a .675 improvement) can still be accomplished but on a month to month basis the aggregated MOE can only measure an improvement or decrease in performance relative to a previous month.

Both methods of aggregating MOEs are averages and, as such, the overall MOE will be a weighted average. In the circumstances where five of the six measures go up a small amount, and the remaining measure goes down significantly, this will (most likely) reflect a decrease in effectiveness for the Finance Center. This may not be in agreement with the subjective judgement of Management personnel. The only method which can change this is the utilization of a Utility Measure. These are discussed in the next chapter and are, in the author's opinion, the best long term measurement method for the Finance Center.

It should be noted that either the weighted-linear or weighted-product method offer the Finance Center a better measure of overall performance then is available at the current time. The author's recommendation would be that the Finance Center use the weighted-product method (with the improvements listed in this Chapter implemented). This will allow the Center to establish an overall MOE process and begin to utilize it while the additional analysis necessary to use Utility Measures is ongoing. The use of this measure may evoke additional input and insights into the utility analysis and allow the staff of the Finance Center a more understandable starting point.

APPENDIX A
MARINE CORPS FINANCE CENTER GOALS AND OBJECTIVES

Ultimate Aim: Provide the best possible pay service to the active, reserve, retired and former Marine community. Improving and maintaining the credibility and professionalism of the Marine Corps Finance Center.

Continuing, Ongoing Goals

1. Provide timely, accurate, responsive and effective disbursing system.
   - Foster teamwork and interaction among divisions/offices in the analysis and accomplishment of efforts supporting the Center's mission.
   - Resolve critical pay issues in a timely, accurate manner and in accordance with appropriate legislation.
   - Ensure responses to general correspondence are timely, accurate, concise, and courteous.
   - Improve, simplify and more expeditiously process special correspondence.
   - Improve and maintain a vigorous and effective Debt Management Program.
   - Maintain effective liaison/communications within the Marine Corps as well as external agencies to exchange information/ideas and resolve mutual concerns.
   - Provide maintenance and enhance/upgrade existing automated manpower, pay and accounting systems.
   - Develop pay related management systems.
   - Continually evaluate automated systems to determine modifications due to regulatory and other changes and to forecast long range requirements.

2. Enhance efficiency and effectiveness in managing Center resources.
   - Emphasize and hold individual managers accountable for planning, organizing, directing, and coordinating the activities of their organization.
   - Maintain effective manpower controls and sustain employment level within 5% of authorized strength and within budget constraints.
   - Enhance utilization of personnel resources through improved structuring of organizations and positions.
   - Evaluate and enhance Center operations through Commercial Activity and Efficiency Reviews.

- Increase efficiency of space allocation through identification of alternatives and improved utilization of current resources.
- Continue development of office automation to provide network for inter-division communications and to enhance informational capabilities.
- Ensure optimum usage of micro and personal computers through increased controls and availability of technical assistance.
- Develop and implement a responsive automated system for monitoring and controlling funding allocations including travel and training.
- Improve liaison and effectiveness regarding accounting responsibilities to higher headquarters and supported Marine Corps activities.
- Enhance financial reporting and internal controls regarding civilian payroll activities.
- Administer the Master Labor Agreement in accordance with its spirit and intent.
- Utilize training resources to provide both individual and group development training to sharpen and expand employees' skills.
- Participate in the development of accounting methodology to accommodate new accounting systems.

3. Enhance the morale and welfare of the Center's employees.

- Support the Finance Center Recreation Association to implement and coordinate welfare and recreation programs for both military and civilian personnel.
- Promote positive atmosphere of mutual respect and equal employment opportunity within the Center.
- Improve/expand employment of the handicapped through increased emphasis of program objectives and removal of physical barriers.
- Ensure all hands are promptly informed of changes in personnel policy resulting from recently issued OPM or DON policy statements and regulations.
- Establish a Family Service Center to provide information, assistance, and guidance to military personnel and their families.
- Define and develop the Center's Safety Program to provide professional occupational safety and health technical assistance to all employees.
- Encourage a cohesive working relationship between employees and supervisors through effective management techniques and communications.

"Front-burner" Goals

1. Develop, implement and maintain effective internal controls to assure that all Center resources and assets are safeguarded from fraud, waste and mismanagement.

- Recommend a proposed structure (implement when approved) to support long range planning and oversee internal resource coordination throughout the Finance Center.
- Develop an automated follow-up procedure to monitor corrective action taken on internal and external audit reviews.
- Protect the Marine Corps interest in the processing of claims involving Marine Corps funds.

2. Increase security awareness and identification/resolution of security deficiencies.

- Evaluate manual and automated systems/ security and processes.
- Develop a program to update physical and ADP security directives and improve internal security. Analyze and audit users of automatic systems to ensure security deficiencies/violations are detected and corrected.

3. Develop "measures of effectiveness" to monitor and evaluate quality of Center operations.

- Determine appropriate indicators to identify and weigh relative changes in efficiency and effectiveness of Finance Center elements/functions against the resources invested.
- Determine appropriate criteria to measure effectiveness of the three major pay systems.
- Determine appropriate criteria to measure effectiveness of support functions, i.e., processing of personnel actions, purchasing requests, etc.

4. Present proposed alternatives to accomplish functions and responsibilities of mutual interest to HQMC and MCFC.

APPENDIX B
ORIGINAL DATA AND DESCRIPTION OF DATA ELEMENTS

Data Element Description: SupEnfTot - Support Enforcement Activity Totals. These activities include Manual Payments, Suspension of Monies, Allotments begun, Cases closed, and members discharged from the Service.

Original Monthly Totals:

July 85	653
August 85	665
September 85	667
October 85	694
November 85	669
December 85	723
January 86	732
February 86	745
March 86	754
April 86	784

Data Element Description: InqCompl - Inquiries Completed. These actions include Speedletters, phone calls, Messages, and Reports which require investigative measures of a Marines pay account and the response being completed.

Original Monthly Totals:

July 85	601
August 85	478
September 85	669
October 85	684
November 85	526
December 85	861
January 86	959
February 86	752
March 86	859
April 86	780

Data Element Description: DaySpec - Daily Specials Processed. These are cases where a physical check has to be produced by the Finance Center and sent to the servicemember.

Original Monthly Totals:

July 85	3061
August 85	2955
September 85	2690
October 85	2486

November 85	2240
December 85	1171
January 86	2352
February 86	2429
March 86	2816
April 86	2232

Data Element Description: CanChks - Cancelled Checks. These actions measure check cancellations during the two main pay cycles each month, the monthly allotment program run, or the Retired pay program run.

Original Monthly Totals:

July 85	2907
August 85	2595
September 85	2540
October 85	2273
November 85	2284
December 85	3003
January 86	1181
February 86	1858
March 86	1991
April 86	1952

Data Element Description: EFTRtns - Electronic Fund Transfer Returns. Occurs when a Marines account at another financial institution is closed and the Finance Center attempts to transfer funds to that account. This process must then be corrected.

Original Monthly Totals:

July 85	39
August 85	60
September 85	69
October 85	87
November 85	51
December 85	30
January 86	33
February 86	43
March 86	43
April 86	52

Data Element Description: TotTranInp - Total Transactions Input. On line Diary system entries input by the Analysis Unit due to their inability to be input by a field unit.

Original Monthly Totals:

July 85	4675
August 85	1929

September 85	1467
October 85	1699
November 85	1289
December 85	3122
January 86	2293
February 86	4924
March 86	4920
April 86	7883

Data Element Description: LvBalCor - Leave Balance Corrections. Occurs during the audit of Enlistment and Reenlistment Bonus Vouchers when a Marine reenlists.

Original Monthly Totals:

July 85	150
August 85	76
September 85	164
October 85	115
November 85	135
December 85	147
January 86	172
February 86	138
March 86	130
April 86	132

Data Element Description: PayReconPro - Payroll Reconciliation. Monthly audit of a specified number of servicemembers record books to ensure correct pay process is occuring.

Original Monthly Totals:

July 85	3629
August 85	3662
September 85	3725
October 85	3134
November 85	3367
December 85	3429
January 86	4116
February 86	3298
March 86	3617
April 86	3620

Data Element Description: TotTODES - Total TODES Issued. A correction to the servicemembers automated pay record is made after the Enlistment/Reenlistment Voucher audit.

Original Monthly Totals:

July 85	344
August 85	252

September 85	348
October 85	289
November 85	261
December 85	348
January 86	338
February 86	332
March 86	305
April 86	253

Data Element Description: ManPmts - Manual Payments. Reserve Manual Payments made for any of a number of reasons.

Original Monthly Totals:

July 85	48
August 85	38
September 85	43
October 85	61
November 85	32
December 85	105
January 86	21
February 86	51
March 86	51
April 86	24

Data Element Description: SpecPayOL - Special Payments Processed On-Line. Reserve payment corrections input after normal input received from field units.

Original Monthly Totals:

July 85	2680
August 85	4708
September 85	1873
October 85	902
November 85	975
December 85	1212
January 86	749
February 86	920
March 86	909
April 86	692

Data Element Description: TodInpOL - TODES Input On-Line. Corrections to field inputs received throughout the month.

Original Monthly Totals:

July 85	3336
August 85	4385
September 85	3176
October 85	2759

November 85	3725
December 85	2378
January 86	3081
February 86	2670
March 86	1679
April 86	2379

Data Element Description: ChkFrAutoCan - Checks from Automatic Cancellation. Reserve pay process produces a listing of checks which should not be produced due to some violation of internally programmed codes. These are checked for accuracy and completeness.

Original Monthly Totals:

July 85	3309
August 85	3422
September 85	1151
October 85	382
November 85	784
December 85	479
January 86	209
February 86	286
March 86	874
April 86	486

Data Element Description: AddrChg - Address Changes. Change of address is received for sending a monthly bond or allotment from servicemembers pay.

Original Monthly Totals:

July 85	1769
August 85	1869
September 85	2128
October 85	1402
November 85	1492
December 85	1722
January 86	1406
February 86	1886
March 86	1362
April 86	1300

Data Element Description: ChksCanc - Checks Cancelled. Allotment cancellations discovered after the checks are produced.

Original Monthly Totals:

July 85	190
August 85	191
September 85	200
October 85	162

November 85	289
December 85	221
January 86	171
February 86	247
March 86	199
April 86	154

Data Element Description: BondRef - Bonds Refunded. Servicemember has previously cancelled his purchase of a Savings Bond and is still deducted on the pay cycle. These funds must then be refunded to the members pay account.

Original Monthly Totals:

July 85	14
August 85	13
September 85	11
October 85	5
November 85	5
December 85	8
January 86	3
February 86	12
March 86	6
April 86	1

Data Element Description: RetroPay - Retroactive Payments. Errors have occurred for multiple months.

Original Monthly Totals:

July 85	30
August 85	22
September 85	58
October 85	21
November 85	10
December 85	68
January 86	62
February 86	159
March 86	26
April 86	29

Data Element Description: NoPostErr - Errors discovered upon the posting of the automated tape production for transfer of bulk funds to institutions such as Navy Federal Credit Union, etc.

Original Monthly Totals:

July 85	7004
August 85	3723
September 85	2929
October 85	1861

November 85	2073
December 85	2879
January 86	4634
February 86	3800
March 86	9557
April 86	2595

Data Element Description: CasesSettled - Cases Settled. Consolidated Disbursing Division, Travel Branch travel claims cases settled during the month.

Original Monthly Totals:

July 85	3108
August 85	4116
September 85	3395
October 85	3216
November 85	3950
December 85	3993
January 86	3720
February 86	3345
March 86	3593
April 86	3739

Data Element Description: SettProc - Cases Settled. Settlement Division Travel Claims Processed during the month.

Original Monthly Totals:

July 85	560
August 85	569
September 85	428
October 85	452
November 85	421
December 85	412
January 86	348
February 86	391
March 86	374
April 86	389

Data Element Description: CasesProc - Cases Processed. Measure includes the Separation cases requiring audit(including cases where final settlement is required) and the number of disbursements where payments had to be made because errors where found in the servicemembers favor.

Original Monthly Totals:

July 85	2467
August 85	2345
September 85	2618
October 85	2257

November 85	3292
December 85	3114
January 86	3155
February 86	2341
March 86	3170
April 86	4005

Data Element Description: CompCases - Completed Collection Cases. Settlement Division Indebtedness Branch cases where the indebtedness has been waived, adjusted, dropped, notification completed, or a waiver request completed.

Original Monthly Totals:

July 85	1777
August 85	2295
September 85	2537
October 85	2764
November 85	2191
December 85	1767
January 86	1467
February 86	1223
March 86	2520
April 86	2325

Data Element Description: ChgsReq - Changes Requested. System Management Division programming changes requested of MCCDPA.

Original Monthly Totals:

July 85	54
August 85	28
September 85	28
October 85	19
November 85	28
December 85	26
January 86	29
February 86	13
March 86	17
April 86	19

Data Element Description: OBStrth - On-Board Strength. Civilian Strength for the month.

Original Monthly Totals:

July 85	810
August 85	809
September 85	828
October 85	815
November 85	822

December 85	822
January 86	831
February 86	820
March 86	815
April 86	799

Data Element Description: AuthLev - Authorized Level. 98% of Total Civilian Authorized strength. This is the funded level of employment in the budget.

Original Monthly Totals:

July 85	841.8
August 85	841.8
September 85	841.8
October 85	840.8
November 85	839.9
December 85	839.9
January 86	839.9
February 86	861.4
March 86	861.4
April 86	858.5

Data Element Description: PersFactor - Personnel Factor. On-Board Strength divided by Authorized Level.

Original Monthly Totals:

July 85	.9622
August 85	.961
September 85	.9836
October 85	.9693
November 85	.9787
December 85	9787
January 86	.9895
February 86	9519
March 86	9461
April 86	.9307

APPENDIX C
OVERVIEW OF ADDITIONAL DECISION CRITERIA AND UTILITY MEASURES

Quade and Boucher [Ref. 5: page 8] state, "The first and one of the most important tasks of the systems analyst is to discover what objectives the decisionmaker is, or should be, trying to attain through the options open to him, and how to measure the extent to which they are, in fact, attained. A criterion is a rule or standard for ranking the alternatives in order of desirability and indicating the most promising." Without at least an ordinal ranking by the decision maker, the search for measures of effectiveness becomes a contradiction in terms and no amount of analysis can discover a solution. However, a short review of methodologies to assist the decision maker in arriving at a quantifiable or ranked ordering of events might assist the decision maker in selecting his objectives.

1. DECISION THEORY

D. W. Bunn [Ref. 6: page vii] states, "Applied Decision Analysis takes a practical perspective in the study of techniques to aid decision makers faced with complex problems," and he continues, "... the most widely used definition of decision is that it is a choice among alternatives." Decision Analysis attempts to help the decision maker by allowing him to list all alternatives of concern. Then by examining the resulting returns, or costs, of that alternative under the possible future states of nature which could occur, the decision maker is given additional insight into the problem.

Decisions may be classified according to the information we have about the future states, i.e., as decisions under certainty, risk, or uncertainty. A decision under certainty is one in which we assume one future state will occur with a probability of 1 and we choose the best alternative for that state. A decision under risk is one in which we can estimate the probability distribution of the future states. A decision under uncertainty is one in which the decision maker is unable or unwilling to estimate the probabilities of the future states. Principles of choice available to the decision maker under each of the three situations are discussed briefly below.

a. Certainty

This situation for the states of nature occurs when a single state of nature will occur with a probability of 1. The obvious choice is to pick the best alternative under

that state of nature (where best is defined as the one with the highest payoff or the minimum cost).

b. **Risk**

1. Expectation

The expectation principle implies that we choose the alternative whose expected value payoff or expected cost is the best. This choice is accomplished by multiplying the state probabilities and the values and summing across each row alternative. The resulting summations are then ranked highest to lowest (or reverse for costs) and the maximum or minimum chosen.

2. Most Probable Future

Similiar to the decision under certainty in that you choose the state with the greatest probability of occurance and pick the best alternative from that state as if it were a certainty.

3. Expectation-Variance

This principle concerns itself with the consistency of the payoff/costs. It is generally used more as a tie breaking method for the Expectation, MPF, or Aspiration Level principles. Helps determine the variation among the returns for each different alternative across the states of nature.

4. Aspiration Level

This principle is used if the decision maker has a certain aspiration about the return. An example would be if the DM wanted a return of at least X amount or a cost no greater than Y. Using this principle the DM sould choose so as to maximize the probability of achieving his aspiration. Values which are below his aspiration (for profit) or above his aspiration (for cost) are ignored from the summation. The alternative that is maximizes/minimizes the expected return above the aspiration level is chosen.

c. **Uncertainty**

1. LaPlace

Says we should assign equal probabilities to all future states and choose the alternative with the best expected value.

2. Minimax or Maximin

We choose so as to minimize our maximum cost or maximize our minimum gain. The minimum cost/maximum gain is observed down all alternatives and the alternative with the minimum or maximum is chosen. Sometimes referred to as the pessimistic approach.

3. Minimin or Maximax

This is the optimistic version of the decision principle above. Minimize the minimum cost or maximize the maximum gain.

4. Hurwicz α

A compromise principle which attempts to resolve the difference between the extremely pessimistic and extremely optimistic approach. The decision maker must select a "level of optimism", α , which is $0 \leq \alpha \leq 1$. Then for gains the DM should choose the alternative which maximizes Equation C.1.

$$H_i = \alpha \max V_{ij} + (1-\alpha) \min V_{ij} \qquad \text{(eqn C.1)}$$

For costs the alternative which minimizes Equation C.2.

$$H_i = \alpha \min V_{ij} + (1-\alpha) \max V_{ij} \qquad \text{(eqn C.2)}$$

All of the above decision methods assume one common event. That the decision maker can clearly define alternatives and expected returns/costs based on some future state of nature.

2. UTILITY THEORY

D W. Bunn [Ref. 6: page 42] states, "The essence of utility theory is to provide a function, a utility function, which transforms the payoffs into a utility scale. Having thus transformed all the payoffs into utilities, it then turns out that by taking the expected value of the utilities for a particular alternative (rather than the expected value of the payoffs), we are provided with a ranking of options consistent with the decision maker's certainty equivalents. In other words, the expected utility criterion is coherent." Utility theory asserts that the decision maker can be helped to make coherent choices under uncertainty by defining a person's certainty equivalents. These methods allow the decision maker several methods to analyze his or her own intuition and good judgement to determine a choice between a fixed, known alternative and one which varies (usually between the high and low possible values of the alternative under question) with an unknown probability. The decision maker is asked to determine the probability which would make the two alternatives equivelant and through this choice the DM's risk attitudes are analyzed and a utility function created for each decision.

a. **The Utility Theory Approach**

The von Neumann-Morgenstern [Ref. 7] measure of utility is especially useful in situations involving risk or uncertainty for the individual decision maker. A utility function is the result of a person's attitudes towards risk. The decision maker is asked to rank. or assign a utility value, to varying measures of productivity. From these assigned values, the utility function may be derived. Reference points are required (highest and lowest possible values) and these could easily be determined from historical data (plus or minus 20%). Once these reference points are established, they are assigned the arbitrary values of 0 for the utility of the lowest point and 1 for the utility of the highest point. The author's selection of the values 0 and 1 was arbitrary and could have been any range of values. Next, a value between the low and high value is chosen and the decision maker is given a choice between a 50/50 chance of receiving one of the end points or receiving the chosen middle value with certainty. The decision maker is asked to assign a utility (between 0 and 1) for this choice and the utility of this is noted. The middle point just identified becomes one of the end points and the process is continued until 7 or 8 points throughout the possible range of the production value are computed. From these points the decision maker's utility function may be computed. The resulting utility function represents the subjective attitude of the decision maker to the uncertain outcomes for an objective measure.

The advantage of utility measures is they have defined a certainty equivalent. These values were decided upon by the decision maker during the creation of the utility function and may be interpreted as the minimum amount the decision maker would be willing to forego to eliminate an undesirable risk. The advantage of this certainty equivalent is that it allows valid decisions to be made on computations of Expected Utility. It has, built in, a natural preference ordering based on the expert opinion(s) of the staff or decision maker. As such, it is not just a mathematically constructed model, but a representation of the actual opinions of good or bad of the personnel involved with the operation and management of the Finance Center.

The primary advantage to utilizing utility values lies in the previously computed tradeoff of attribute values and the establishment of the certainty equivalents. A tradeoff of objective values can be easily made since the utility of .6 for one objective is exactly equal to the utility of .6 for another objective. Due to this inherent ability to trade off linearly between objectives, the simpler weighted-linear model may be used to aggregate the objectives into an overall MOE without significant loss of accuracy or detail.

The disadvantages are primarily in the effort required for the analysis and the time required to formulate the utility function for each attribute. This effort could be compounded at the Finance Center because it would be this author's recommendation that the Commanding Officer, Executive Officer, and the Deputies for Financial and Support Operations all be involved in the process of computing the utility function. By examining each of these individuals, and then aggregating their individual utility functions into one overall utility function for the Finance Center it is felt a much more accurate and agreeable measure would exist.

3. THE DOMINANCE APPROACH

The overall Measure of Effectiveness is observed to improve by simply observing all individual MOEs as being greater than or equal to the previously observed values for the MOEs.

The advantages of this method are that this is the only universally accepted measure of improvement/decrease in a multiattribute or aggregated MOE value. In addition, it is obviously quite simple to observe if all individual MOE values are greater then the previous months values. It demonstrates convincingly that the overall MOE (E) has improved if all individual MOEs improve. Reverse is true for a decline in the overall MOE.

The disadvantage of this method is the fact that it is unrealistic. The vast majority of situations will show an improvement in some of the MOEs and a decline in others. Dominance will allow nothing but a cut and dried choice of all have improved/declined or the result is unknown.

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